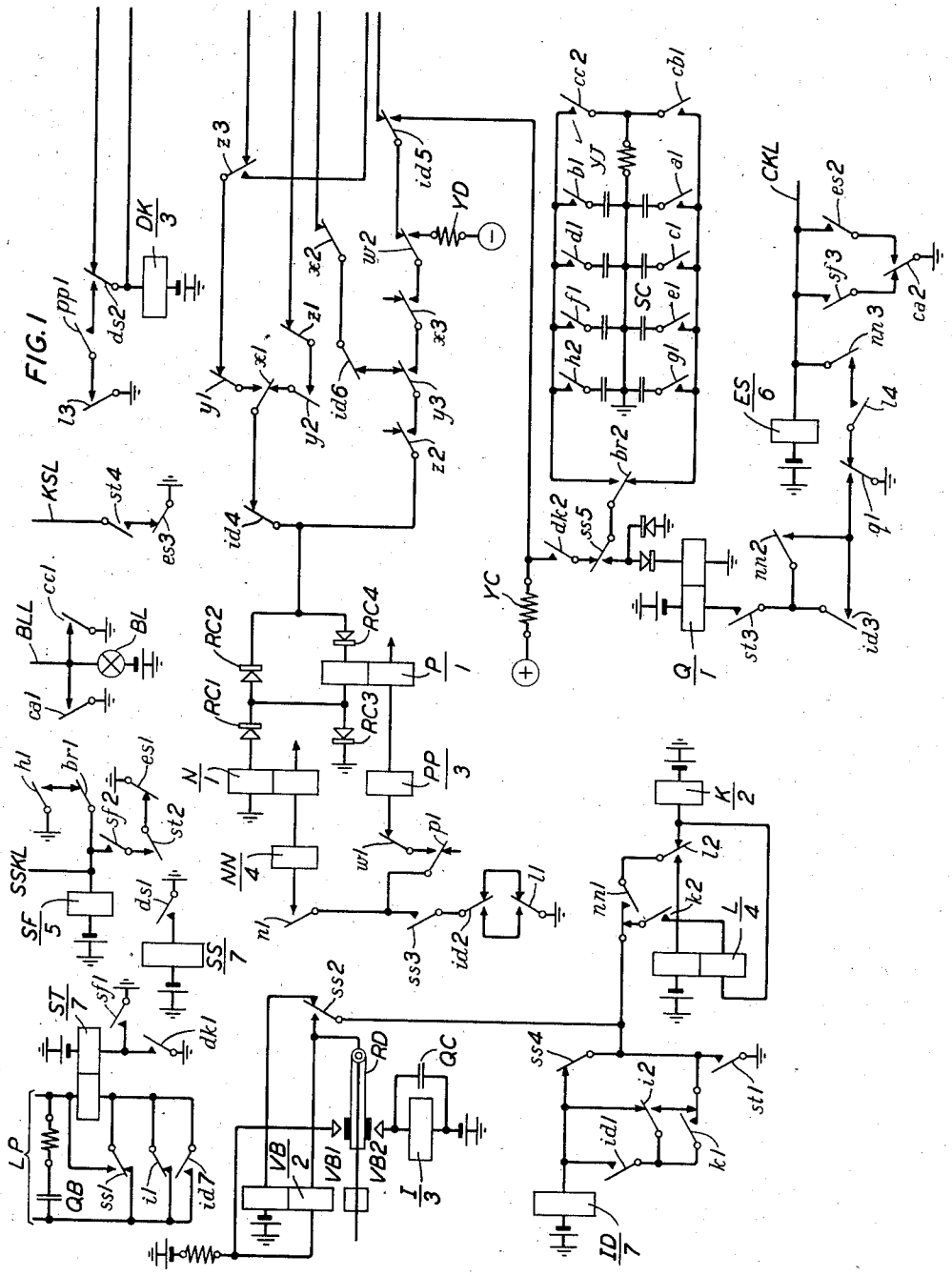
June 23, 1942. G. C. HARTLEY ET AL 2,287,613

KEY PULSING SENDER FOR TELEPHONE SYSTEMS

Filed April 17, 1940 3 Sheets-Sheet 1

FIG. 1



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Filed April 17, 1940 3 Sheets-Sheet 2

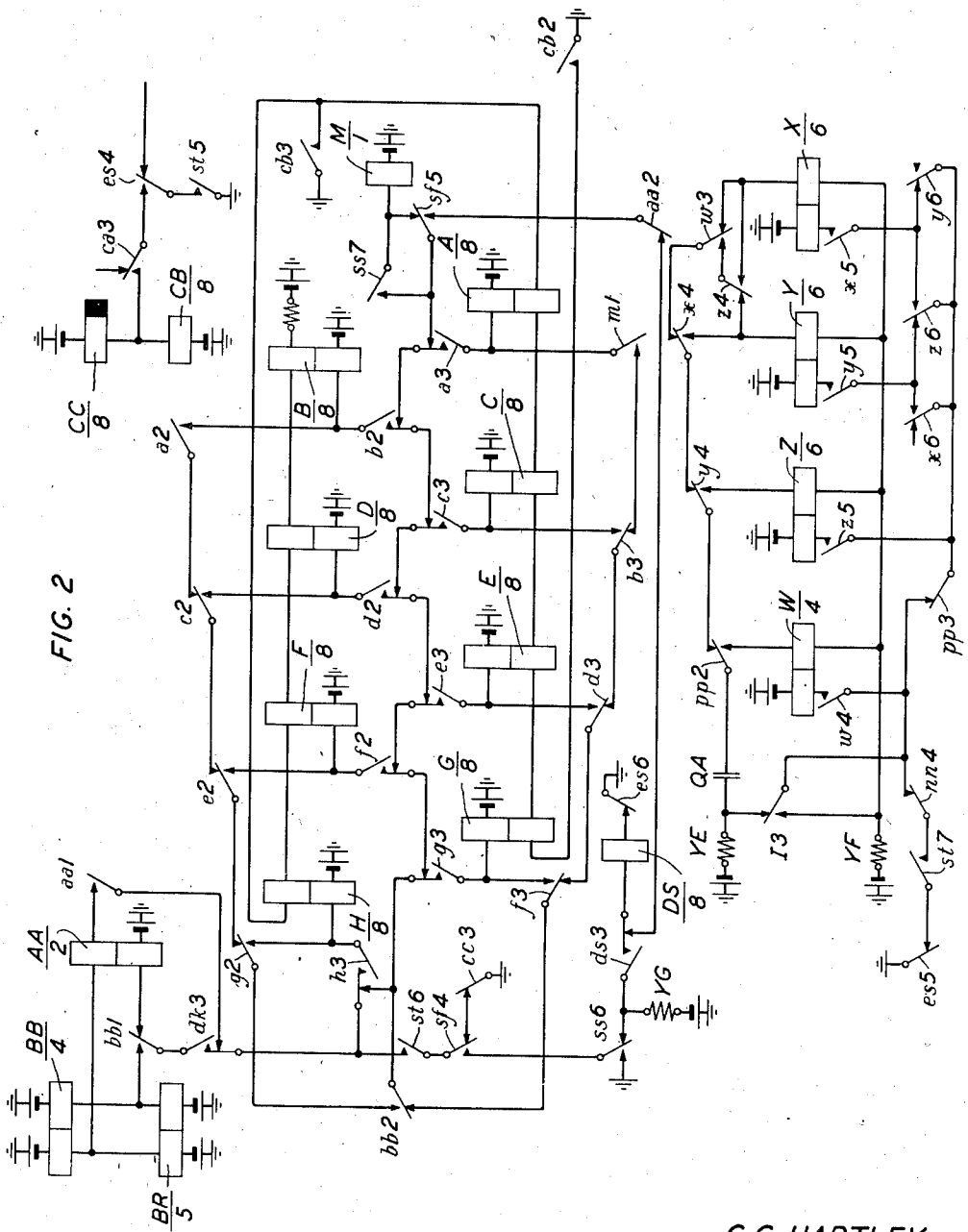

FIG. 2

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Filed April 17, 1940 3 Sheets-Sheet 3

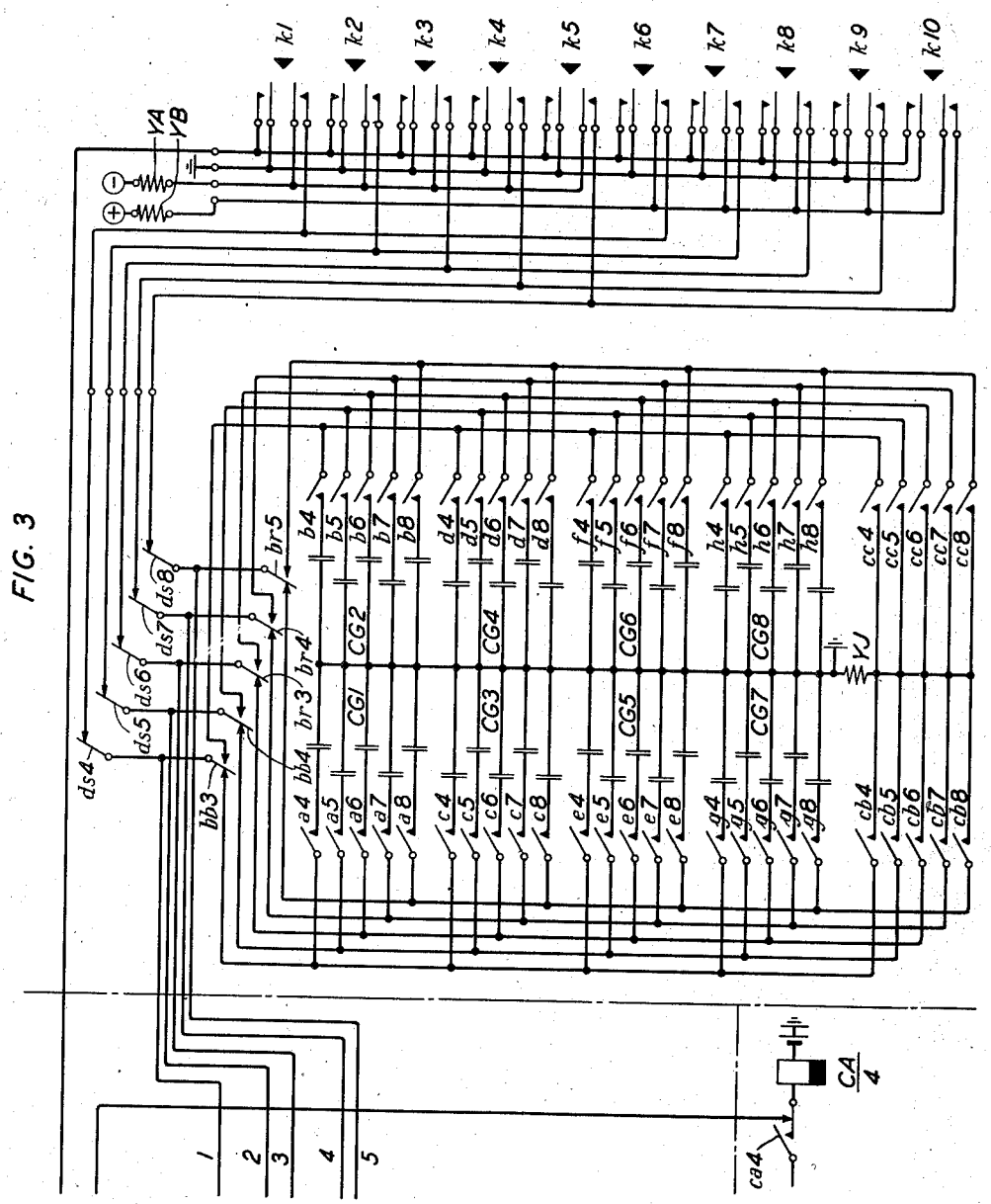

FIG. 3

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2,287,613

KEY PULSING SENDER FOR TELEPHONE SYSTEMS

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7 Claims. (Cl. 179—90)

This invention relates to electrical storage and control equipment, for instance, telephone operators' digital key sender equipment.

The object of the present invention is to render such equipment more flexible in operation.

According to the main feature of the invention electrical storage and control equipment comprises a number of storage devices for individual items such as digits, is arranged to exercise electrical control in accordance with each of a number of individual items stored in said storage devices in turn, and comprises automatic test means for testing after each individual control has been exercised whether any further item is stored.

The invention will be clearly understood from the following description of one embodiment shown in the accompanying drawings which show the circuits of a telephone operator's key sender. Fig. 3 should be placed to the right of Fig. 1 and Fig. 2 below Fig. 1.

The circuit is associated with a number of manual board cord circuits via an intermediate dialing circuit (not shown) of known type The loop circuit LP is connected to two make-before-break contact springs of a relay KS in the dialing circuit. Relay KS is not shown but is connected to lead KSL. The front contacts of the KS springs are commoned to the dial key contacts of said circuits. To set up a call the operator inserts the calling cord in the required outgoing jack, and throws the dial key. This is without effect as the KS contacts are open. The operator now keys the number required.

When the dial key is thrown nothing is disturbed in the sender. When any key K1 to K10 is depressed, however, the circuit is seized by the operation of DK and CA in parallel, followed by ST, which operates KS via KSL. Relay KS switches through the calling loop to the sender so that ST holds to the feed current. Relay ID energizes via *ss*4, *st*1. Relay M operates via *sf*5, *a*3, *b*2, *c*3, *d*2, *e*3, *f*2, *g*3, *h*3, *st*6, *sf*4, *cc*3. Relay A then energizes via *m*1, *b*3, *d*3, *f*3, *bb*2, *h*3, *st*6, *sf*4, *cc*3.

Contacts *a*4 to *a*8 connect a group of condensers CG1 to the keystrip, and one of them will receive a charge. This charge will be negative for digits 1 to 5 and positive for the digits 6 to 0.

Relay AA is also operated via *bb*1, *dk*3, *st*6, *sf*4, *cc*3. CA has locked via *ca*4, *es*4, *st*5. When DK releases, AA holds via *aa*1 operated, *dk*3 normal in series with parallel windings of BB and BR, which operate. When the second digit key is depressed DK operates again, holding BB, BR on their second windings over *bb*1, *dk*3 and releasing AA. When DK releases again, it releases BB and BR. Thus relays BB and BR are operated for the second, fourth, sixth and eighth digits, and back for the first, third, fifth, and seventh digits. BB and BR are used to actuate the main group switching train, and their contacts *bb*3, *bb*4, *br*3, *br*4, *br*5, are used to switch the charging leads from the keys to the "odd" or "even" banks of the condenser groups CG1 to CG8.

The main group switching train consists of eight switching relays A to H and one guard relay M. Its operation is as follows. As set out above, ST operates when the first digit key is depressed, and earth is extended to M, which operates and completes a circuit for A, which also operates. A locks on its upper winding via *a*3 and releases M. When BB operates on release of the first digit key, earth is placed on the lower winding of B via *a*2, *c*2, *e*2, *g*2, *bb*2, *h*3, *st*6, *sf*4, *cc*3. B operates and locks via *b*2 to the earth which it disconnects from A. A releases. When BB releases on depression of a key for the second digit, earth is fed to C via *b*3 front, *d*3, *f*3, *bb*2. C operates and locks to the earth which it removes from B. B releases, but A does not reoperate as M is back.

Thus at each movement of BB the next relay in the chain A to H is operated, and the previous relay released, till H is operated, when further keying will produce no effect. The change in condition of the train takes place as BB operates or releases, which takes place as DK releases in both cases, that is when the digit key is released. Thus as charging is finished, and the key is released, switching takes place and the next group of condensers is connected to the digit keys. The operations of the relays A, B, C, D, E, F, G, H overlap one another, so that condensers are divided into two banks, the "odd" bank taking the first, third, fifth and seventh digits, the "even" bank the second, fourth, sixth and eighth digits. As described above, switching between banks is effected by BB and BR, which are operated for even digits and back for the odd digits, preventing the sharing of charges due to overlap.

The circuit is set to start sending on the release of the key storing the eighth digit, but provision is made to enable the sender to start sending when three, four, five, six or seven digits have been keyed. A start sending key (not shown) is provided in the cord circuit to enable fewer digits than the possible maximum to be sent. To

prepare the circuit for sending, relay SF is operated either from the operator's send key via lead SSKL, or via contacts *h1*, *br1*. When the eighth digit key is restored SF locks via *sf2*, *st2*, *es1*. One of the relays A to H will be operated, and holds to earth via change-over contacts *sf4*. When SF operates, this earth is removed, and a 10 ohm battery via YG, *ss6* substituted. Contacts *sf5* disconnect relay M, and prepare a circuit for DS; earth, back contacts *es6*, DS, back contacts *ds3*, *aa2*, front contacts *sf5*, back contacts *a3*, *b2*, *c3*, *d2*, *e3*, *f2*, *g3*, *h3*, *st5*, *sf4*, *ss6*, YG, battery. DS has a high resistance to ensure the release of the relays A to H, as they get a temporary circuit in parallel with YG during release. DS operates when the relays A to H and AA are back, and operates SS, starting the sending. Contacts *ds4* to *ds8* disconnect the keystrip from the condensers, and contacts *ds2* transfer the control of DK to make contacts *pp1*, *l3*. ST is held via *sf1*, and the winding of ST in the loop is short-circuited by SS. Contacts *ss4* open the circuit holding ID, which releases. Contacts *ss3* prepare a locking circuit for P and N, and contacts *ss8* reconnect earth to the condenser switching train, operating M. M completes a circuit for A which operates, releasing M.

When ST operated, earth via *st1*, *sc2* energized a locking winding of a reed vibrator relay VB. The reed RD is thereby held on its lower contacts. When SS operates, impulse relay I operates while reed RD is allowed to vibrate. A circuit is completed for an additional winding of VB which is short-circuited each time the reed closes contacts *vb1* and which maintains the reed in oscillation.

Sending

I has three contacts; break contacts *i1* to send the impulses out, change-over contacts *i2* to synchronize the operation and release of ID, and change-over contacts *i3* to actuate the impulse counting train. This train consists of four relays, three of which, X, Y, Z, count the first five impulses, the fourth, W, being used to count the sixth while X, Y and Z release, preparatory to counting the remaining four impulses as described below. The relays X, Y, Z, W also connect the sensitive relays P and N to each condenser of a group in turn, so that the group is tested in sequence. X, Y, Z, W are operated by the current produced in one winding when the charge on a 2 microfarad condenser QA is reversed by the operation of I. This current operates their contacts *w4*, *x5*, *y5*, *z5*, only and their operation is completed on their second windings, the relays locking to earth on *es5*.

The operation of ST connected earth via *es5*, *st7*, *nn4*, *i3* to one side of condenser QA the other terminal of which is normally connected to battery via *pp2*, *y4*, *x4*, *w3*, right-hand winding of X, resistance YF. QA charges but the current is insufficient to operate X.

When impulsing begins, operation of contacts *i3* reverses the earth and battery connections to QA and X, short-circuiting 5000 ohm resistance YF and introducing 200 ohm resistance YE. In consequence QA discharges and recharges in the opposite direction, operating X which locks via its left-hand winding, *x5*, *y6*, *pp3*, *nn4*, *st7*, *es5*. Contacts *x4* change over the condenser circuit from X to Y. The first condenser of group CG1 is now connected via *a4*, *bb3*, *z3*, *y1* *x1*, *id4* to relays N, P to test whether the condenser is charged and if so the polarity of the charge.

Release of I returns contacts *i3* to normal reversing the battery connections to QA again; however the introduction of high resistance YF in place of YE reduces the strength of current flowing through the condenser circuit and Y does not operate. On the second operation of I, Y is operated via QA, locks via *y5*, *z6* and releases X at *y6*. The second condenser of CG1 is now tested.

On the third operation of I, relay Z is energized and locks, releasing Y, and the third condenser is tested.

Relay X is again connected to QA and when I is energized for the fourth impulse X reoperates and locks via *x5*, *z6*. The fourth condenser is connected to relays N, P via *id4*, *x1*, *y1*, *z3* and tested.

The fifth impulse operates Y which also locks up without releasing X or Z, and the fifth condenser is tested via *z2*, *y3*, *x3*, *w2*, *id5*.

When the charged condenser of CG1 is found, N or P energizes according to the polarity of the charge. The rectifier arrangement shown for these relays is designed to provide individual inductive circuits for the relays, whereby discharge via one relay will not set up current flow via windings of both relays and their rectifiers in series. Relay N has a circuit via RC1, RC3 independent of relay P which likewise has an individual circuit via RC4.

The sequence of operations for X, Y, Z is therefore:

During 1st impulse X operated, condenser 1 tested.

During 2nd impulse Y operated, condenser 2 tested.

During 3rd impulse Z operated, condenser 3 tested.

During 4th impulse ZX operated, condenser 4 tested.

During 5th impulse ZXY operated, condenser 5 tested.

The condensers can be charged positively or negatively, as explained above. If there is a negative charge on any of the five condensers, N operates and locks in series with NN via *n1*, *ss3*, *id2*, *l1*. K operates via *l2*, *nn1*, *st1*. NN releases X, Y, Z. K prepares a circuit for ID which is completed via *i2*, *k1*, *st1* when I releases. ID operates, and locks via *id1*, *k1*, shorting the impulsing loop at *id7* and disconnecting the condenser groups at *id4*, *id5*, *id6*. ID also releases N and NN, operating L via *k2*, *nn1*.

Should there have been a positive charge on the condenser, when this was reached, P and PP would operate, releasing X, Y, Z, but connecting W to the operating circuit. W takes the sixth impulse, operates, and releases P and PP; this again brings in X, Y, Z which have by now released.

Owing to W being operated, the seventh impulse is directed via *z4*, *w3*, *x4*, *y4*, *pp2* to Y; the eighth impulse is directed to Z, which releases Y; the ninth operates X; while the tenth reoperates Y. While these last four impulses are being sent, W is operated, and connects a negative potential via YD, *w2* in place of the fifth condenser. When the lead to the fifth condenser is reached, N is operated, operating NN. NN releases X, Y, Z, W, and operates K, which, as before, prepares a circuit for ID over back of *i2*. ID operates when I releases, locking over the front of *k1*, shorting the impulsing loop at *id7*, and disconnecting the condensers. ID releases N and NN, which operates L, and substi-

tutes for the fifth condenser a positive potential. K holds in series with L via *k2*, *nn1*, *st1*.

When NN releases the circuit is completed again at *nn4* for X. Y, Z, W, which start counting the operations of I. The circuit is set to count 10 impulses with the loop shorted to give the necessary interdigital time. On the fifth impulse the positive potential applied by *id5* operates P and PP, causing a further five impulses to be counted out. At this time L is operated, so that midway in the interdigital time DK is operated via *ds2*, *pp1*, *l3*. As before, AA energises via *bb1*, *dk3*, *st6*, *sf4*, *cc3*. Relay W operates on the sixth impulse releasing P, PP, and DK. AA locks in series with BB and BR, and B energizes via *a2*, *c2*, *e2*, *g2*, *bb2*, *h3*, *st6*, *sf4*, *cc3*, and releases A. Relays BB, BR and B switch in the second group of condensers CG2 to be tested for the next digit.

When N and NN are operated at the end of the interdigital time via *w2*, K is first released, and ID is held over a front of *i2* till I releases, when ID is dropped. ID connects the testing relays N, P to the second group of condensers, removes the short-circuit from the impulsing loop, and releases N and NN. NN releases L which had held on release of K via operated contacts *l2*, *nn1*, *st1*, and restores the circuit for X, Y, Z, W, which, under the control of I, start testing the next group of condensers.

End of sending

In order to limit the testing of condenser groups to those in which a digit has been stored, a bank of eight condensers SC is provided, one for each group of condensers, which are charged positively if a digit has been stored in the respective group of digit condensers. These condensers are charged via *dk2*, *ss5*, the condensers being connected up in turn by contacts of BR and relays A to H. During sending, as each condenser group CG is connected up, the corresponding condenser SC is connected to relay Q. If a digit has been stored in that group, Q will operate to the charge on the pilot condenser SC, locking via *st3*, *id3*, *q1*. If no digit has been stored, Q will not operate, and relay ES will be operated via front contacts *nn3*, *l4* and back contacts *q1* when NN operates at the end of the interdigital time. ES locks to front of *ca2*. Relay CA was operated when the first digit key was depressed and locked via *ca4*, *es4*, *st5*. This circuit is now opened. CA is slow to release, so that with ES and CA operated, a circuit is given for CB and CC to operate temporarily. The function of these relays is to cancel any residual charges on all condenser groups CG. This is achieved by operating all the relays A to H via *cb2* and earthing the two banks of leads via 50 ohms resistance YJ. Relay CC is slow to release, so that the locking earth for A to H relays which was removed by *cc3* is not replaced until a small interval after their release by CB. Contacts *es3* remove the circuit for KS in the dialing circuit which releases, removing the loop from the sender. Contacts *es1* open the locking circuit for SF, which releases, dropping ST. ES then releases. The circuit is now free.

Guards and precautions

If the operator desires to send less than the maximum number of digits for which the sender is set, she keys up the required digits and presses her start send key, which operates SF and starts the sending process. To guard against the sender endeavouring to send when no digits have been keyed, but the start send key depressed, CA is made to operate and lock up when a digit key is depressed. Should the start send key be depressed before storing a digit, ES will be operated over front contacts *sf3* and back contacts *ca2* and will open contacts *es1* so that SF will release when the start key is released, returning the circuit to normal.

A cancel key (not shown) is provided to enable the operator to cancel any digits stored or being sent. When depressed it operates ES via lead CKL and the circuit cancels and returns to normal.

What is claimed is:

1. In a telephone system, control equipment comprising a plurality of registering devices, means for setting up registrations on certain of said registering devices, an impulse transmitter, means for placing said impulse transmitter under the control of said registering devices in turn, testing means, and means operated in response to the completed control of said impulse transmitter by each of said registers to render said testing means effective to determine whether a registration exists on the next registering device.

2. In a telephone system, control equipment as claimed in claim 1 in which means is provided under the control of said testing means to restore said control equipment to normal when no registration exists on the tested registering device.

3. In a telephone system, control equipment as claimed in claim 1 characterized by a counting device, means to operate said device in accordance with the number of registering devices on which registrations are set up, and means to operate said testing means under the control of said counting means.

4. Electrical storage and control equipment as claimed in claim 1 and comprising a counting device on which the number of items stored in said storage devices is recorded, said counting device comprising a group of condensers, one for each of said registering devices, and means to charge each condenser while the corresponding registering device receives a registration.

5. In a telephone system, control equipment comprising a plurality of groups of condensers, said groups of condensers identified as odd or even, means to charge the condensers of a group to establish registrations thereon, means to transmit impulses, a relay chain including one relay for each of said groups of condensers, means under the control of each relay to connect the corresponding group of condensers to said charging means or to said impulsing means, means to successively operate said chain of relays, two of said relays remaining operated at the same time, a change-over relay device, means to operate said change-over relay device prior to the operation of each chain relay, and means under the control of said change-over relay device to render only one of said chain relays effective

6. In a telephone system, control equipment comprising a plurality of groups of condensers, means to establish a positive or negative charge on one condenser of a group to set up a registration, impulse transmitting means, means to control the number of impulses sent out by said transmitting means in accordance with said registration comprising two detector relays, a unidirectional current carrying device in series with one of said detector relays, an oppositely directed

unidirectional current carrying device in series with the other said relay, means to connect said detector relays in parallel to the condensers of a group in turn, means under the control of one of said detector relays to terminate said impulse transmission, and means under the control of said other detector relay to cause the transmission of a predetermined number of additional impulses and to operate said one detector relay independent of said condensers.

7. In a telephone system, control equipment comprising a plurality of groups of condensers, means to establish a positive or negative charge on one condenser of a group to set up a registration, and means to determine said registration, comprising two detector relays, oppositely directed unidirectional current carrying devices in series with said relays, means to connect said detector relays in parallel to the condensers of a group in turn, and means to prevent interaction between said detector relays comprising an oscillatory circuit for each of said detector relays independent of the other detector relay.

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